For $\phi = 0$, $r = a$, corresponding to the point A.
For $\phi = 180°$, $r = a \sec 60° = 2a$, corresponding to the point I.
For $\phi = 270°$, $r = \infty$, and the curve becomes asymptotic with the line dm, now tangent at A′ to the arc AdA′.

The curve, extended beyond A, will have two symmetrical branches with reference to the line AI.

The portion shown in Fig. 1 need alone be considered.

This curve possesses the following property:—

If a line is drawn making any angle, PCK, with CP, and from its intersection with the curve, at m, as a centre, an arc be struck with a radius equal to Cm, its intersection with the arc described with radius CI will determine a point C, the line from which to the centre C will trisect the angle ACK.

To Prof. John Peirce, of Providence, the suggested use of the curve is due.

A. H. Russell,
Captain U.S. Ordnance Corps.
Providence, R.I., April 13, 1889.

THE ACTION OF THE NERVES OF THE BATRACHIAN HEART IN RELATION TO TEMPERATURE AND ENDOCARDIAC PRESSURE.

(Preliminary Note.)

This work, which has been carried on during the past four or five months, has been chiefly concerned with the influence of temperature on the action of the sympathetic and the vagus, and only incidentally with the effect of endocardiac pressure. A re-investigation of the heat standstill of the heart has also been connected with the work. In most of the experiments tracings of the auricular and ventricular movements were taken simultaneously, and these were supplemented by a series of electrical observations.

Omitting details, the chief results are as follows. The term "vagus" is here used in its anatomical sense to denote the mixed vago-sympathetic trunk.

(1) Both the vagus and the sympathetic have their activity diminished as the temperature is lowered and increased as the temperature rises, whether changes in the rhythm or in the amplitude of the beats be taken as the test of activity. The sympathetic curve, however, falls more steeply with falling temperature than does the vagus curve, so that the vagus is generally still active with a temperature at which the sympathetic has ceased to react.

The secondary augmentor effects of vagus stimulation are extremely well marked at the higher temperatures, and become less conspicuous as the temperature is lowered. Not only are both nerves active on the very threshold of the heat standstill, but during the actual standstill, when it has not been obtained at too high a temperature, stimulation of the sympathetic may rouse the heart to vigorous contraction.

(2) An increase of endocardiac pressure sufficient to abolish the inhibitory action of the vagus leaves the sympathetic still active, and the primary augmentation which, under these conditions, has been seen as a result of vagus stimulation, may be attributed to the sympathetic fibres in the mixed nerve.

When a high pressure is suddenly reduced, standstill of the heart may occur, and this can be removed by stimulation of the sympathetic.

(3) Heat standstill of the heart, when there is no constant stimulus acting, such as a high endocardiac pressure, is always diastolic, and can never be described as "heat tetanus."

(4) Electrical effects, analogous to those described by Gaskell in the quiescent auricle of the tortoise on stimulation of the vagus, and in the toad's ventricle on stimulation of the sympathetic, have been looked for in vain in the heart of the frog and toad during heat standstill and the standstill caused by sudden relief of a high endocardiac pressure. The effects observed were always related to coincident or consequent mechanical changes.

So far as the sympathetic is concerned, I do not know of any previous work on the subject of this note; nor has the influence of temperature on the vagus been before studied by a suitable graphic method, but only to a small extent in any way and by methods yielding very imperfect information.

New Museums, Cambridge. G. N. Stewart.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—An examination for Minor Scholarships in certain branches of Law and Natural Science will be held at Downing College on Wednesday, July 8, and subsequent days. Candidates for Minor Scholarships in Natural Science must be under the age of nineteen at the time of commencement of the examination, and must send a certificate of birth with their other papers. There is no such limit of age for candidates in Law. Further information will be furnished by the Rev. J. C. Saunders, Tutor of the College.

SCIENTIFIC SERIALS.

The *American Meteorological Journal* for February contains:—An account of a lecture on the State Weather Service, delivered by Prof. F. E. Nipher at the request of the Board of Agriculture of Missouri. These services aim at weather predictions for the use of agriculturists and others, and the forecasts are of a more local character than can be attempted by the Central Office. The general use of the telephone is recommended for the purpose.—Wind-pressures and the measurement of wind velocities, by Prof. C. F. Marvin. This paper recapitulates the experiments which have been carried on in the United States, concurrently with others in this country and elsewhere, to determine more accurately than was at first done the constants of the Robinson cup-anemometer. The instrument used was the small pattern adopted by the Signal Service, the cups of which are 4 inches in diameter, and the arms 6·72 inches long, and for this form of anemometer the equation

$$\log V = 0{\cdot}509 + 0{\cdot}9012v \log v$$

is recommended to be used instead of Dr. Robinson's original formula $V = 3v$, which is commonly applied to all cup anemometers, regardless of size of cup and length of arm. An account is also given of some experiments carried out at the summit of Mount Washington, with a view to determining the wind-pressure upon large plates, and comparing it with the wind velocity recorded by the cup-anemometer. The writer finds that, with ordinary barometric pressures, the wind-pressure can be satisfactorily obtained from the wind velocity by the following formula:—

$$P = 0{\cdot}0040V^2S,$$

where V is the wind velocity in miles per hour, P is the pressure in pounds per square foot, and S is the area of the plate.—Meteorological observations taken in four balloon voyages, by W. H. Hammon. The ascents were made in January, March, and April, 1885, by direction of the Chief Signal Officer. The Report contains full descriptions of the instruments and detailed observations during the ascents, which were made during conditions of the atmosphere that were considered likely to elucidate certain points. The ascents were only of slight elevation, and the observations are to be considered only as contributions to the special weather of the respective dates, and not as bearing particularly upon the questions involved in the general circulation of the air.

SOCIETIES AND ACADEMIES.

London.

Physical Society, March 20.—Prof. W. E. Ayrton, F.R.S., President, in the chair.—Prof. S. U. Pickering, F.R.S., read a paper on the theory of dissociation into ions, and its consequences. According to this theory electrolytes are entirely dissociated into their ions in weak solutions. This dissociation was held by Arrhenius to absorb heat, and although heat is evolved by the dissolution of hydrochloric acid, &c., it is not maintained that dissolution evolves heat, but that the heat absorbed by the decomposition of the molecule into its atoms is more than counterbalanced by the heat supposed to be evolved by the combination of the atoms with their electric charges. These actions the author considered improbable, and thought that before being accepted, the theory must give satisfactory answers to the following questions: How can matter combine with an affection of matter to produce heat? Whence do the electric charges originate? Why does not the opposite electrification of the different atoms make them cling more firmly together, instead of dissolving the union between them? And why should an atom which possesses a strong attraction for a negative charge (such as chlorine) go to the positive electrode during electrolysis? When a dilute solution, which is supposed to contain some gaseous molecules, is further diluted, then, according to the theory, some of the molecules are dissociated, and, if heat is absorbed, it follows that the dissociation, and therefore dissolution, of the gas must absorb heat; yet, he said, it can be shown that in some of these cases the dissolution of a gas evolves a large amount of heat. The antagonism between the present and the old electro-chemical theory, according to which the atomic charges are identical with the free energy of an atom, and are the cause of combination, not decomposition, was commented on, as well as the disagreement between the present theory and Clausius' view that there are a few ions or atoms present in a liquid, owing to accidental superheating of some of the molecules. Reasons, however, were adduced for believing the presence of even a few atoms in a solution to be improbable.—A communication on some points in electrolysis was made by Mr. J. Swinburne. Considering a reversible single fluid cell, the author, by a process of reasoning based on Carnot's principle and the conservation of energy, arrives at Helmholtz's equation—

$$\mathrm{E} = \mathrm{E}_c + \theta\frac{d\mathrm{E}}{d\theta},$$

where E is the electromotive force, E_c the part due to chemical action, and θ the absolute temperature. Writing the equation in full, using suffixes *n* and *p* to denote the negative and positive plates, it becomes

$$\mathrm{E}_n + \mathrm{E}_p = \mathrm{E}_{nc} + \mathrm{E}_{c} + \theta\frac{d\mathrm{E}_n}{d\theta} + \theta\frac{d\mathrm{E}_p}{d\theta}.$$

He then shows that, by having the two plates in different vessels, and heating them to different temperatures, the Peltier effects represented by $\theta\frac{d\mathrm{E}_n}{a\theta}$ and $\theta\frac{d\mathrm{E}_p}{d\theta}$, can be determined separately. Similarly, those of a two-fluid battery might be found by arranging the junction of the fluids in a third vessel. After pointing out the desirability that the conditions under which all thermo-chemical data have been obtained, should be clearly stated, he proceeded to show that any cell in which secondary actions occur (as, for example, if the zinc oxide primarily formed by electrolysis were to dissolve in sulphuric acid) must necessarily be non-reversible. He also contended that, in a secondary battery, the formation of lead sulphate on both plates is the essence of the cell's action, and that there is no intermediate formation of PbO. On the subject of so-called "nascent" hydrogen or oxygen, he said that reasoning from the conservation of energy showed that neither could exist. Taking the case of persulphate of iron in dilute sulphuric acid, which is said to be reduced to protosulphate by the "nascent hydrogen" liberated on putting a piece of metal (say magnesium) into the liquid, he said a better explanation of the phenomena would be, that the metal dissolves, if it either reduces the metal or evolves hydrogen; and as the former requires less energy, the reduction takes place, and, when no reducible salt is available, hydrogen is evolved. Evolution of hydrogen and reduction of the persalt are thus *alternative* and *not consecutive* actions. Examining Dr. Lodge's views on the contact E.M.F. between metals, he remarked that, if the tendency of a metal (such as zinc) to oxidize can produce an electric stress or difference of potential which prevents further combination, actual combination must charge the metal if it be insulated. A piece of sodium, however, oxidizes continuously, and therefore should become charged to an enormous potential. As this effect is not known to occur, the author suggested that the Volta effect may be due to films of water, and, in support of this view, adduced the fact that metals when perfectly dry do not combine with chlorine, and that even sodium is not attacked by dry chlorine.—In the discussion on the two papers, Prof. Pickering said the idea of nascent elements had, to a large extent, been given up by chemists, and pointed out that the fact of one reaction taking place rather than another was not merely a question of heat energy, but that a kind of chemical selection was involved. Prof. S. P. Thompson recalled attention to the fact that the products of electrolysis depend on the E.M.F. employed in producing it, and thought the E.M.F. required to produce the various products might be taken as a measure of their affinities. He did not agree with Mr. Swinburne's method of finding the E.M.F. of a secondary battery from thermo-chemical data, for he failed to see how two similar actions going on at the two plates of a cell could add anything whatever to the E.M.F. of the cell. The President said the question whether the potential difference between two dissimilar substances was due to oxidation or to mere contact could only be decided by direct experiments made in a vacuum, from which all traces of moisture and oxygen had been removed. Without agreeing with Dr. Lodge's view on the subject, he pointed out that the continuous oxidation of a piece of insulated sodium need not necessarily produce a great potential difference, for the combination might merely produce heat.—After Prof. Pickering and Mr. Swinburne had replied to the points raised, Mr. Walter Baily took the chair, and Prof. Perry read a note on the variation of surface-tension with temperature, by Prof. A. L. Selby. Considering unit mass of liquid at constant volume, but variable surface (S) and temperature (t), the author expresses the gain of intrinsic energy due to changes of the variables by

$$d\mathrm{H} + d\mathrm{W} = kdt + (l + \mathrm{T})\,d\mathrm{S},$$

where $d\mathrm{H}$ is the heat absorbed, $d\mathrm{W}$ the work done on the film, k the specific heat at constant volume, l the latent heat of extension, and T the surface-tension. This being a perfect differential, it is shown that $\mathrm{T} = c - bt$, and $l = bt$, c and b being constants. Supposing c and b to be independent of the specific volume of the liquid it is shown that at the critical temperature $t = \frac{c}{b}$, hence this temperature may be determined by finding the surface-tension at two very different temperatures. Since also $l = bt$, the latent heat of extension is proportional to the absolute temperature. Reasons for supposing b to be independent of the specific volume are given in the paper. Mr. Blakesley described an effect of temperature on surface-tension which he had observed in sensitive spirit-levels. By warming one end of the tube, even by the hand, the bubble immediately moves towards that end. This effect, which might produce considerable error in engineering operations, was, so far as he was aware, not mentioned in the text-books. Prof. Perry remarked that although the volume, temperature, and surface of the liquid had been referred to in the paper, pressure was not mentioned, and on this point he inquired whether the results arrived at were true, quite independent of the pressure.—Prof. S. P. Thompson, read a paper on magnetic proof pieces and proof planes. The distribution of magnetism over magnets has been examined in various ways by different observers, but mostly by observing the force of detachment of either rods, ellipsoids, or spheres, &c., used as proof pieces. In all these cases it was, the author said, difficult to see exactly what was measured, for the presence of the proof pieces altered the thing to be tested. The pull exerted must also depend on the permeability of the piece used as well as on its shape and disposition with respect to the magnetic circuit. He had therefore investigated the subject, by finding the actual distributions, by means of a flat exploring coil and ballistic galvanometer, both with and without the presence of proof pieces of various shapes and sizes. The results show that the perturbations produced by the proof pieces are always large, in some cases the perturbed field about a point being four to six times the unperturbed field. In most cases, however, the ratio of the perturbed to the unperturbed field was constant, so long as the former did not exceed 6000 C.G.S. units. The amount of perturbation was also found to depend on the saturation of the magnet and on whether it was a permanent or an electro-magnet. The numbers obtained in various experiments, and curves plotted from such results, were shown. In conclusion, the author said that in using proof pieces, much depended on the accuracy of the contact, but in any case the results attained were not very trustworthy. The flat exploring coil, or magnetic proof plane, however, furnished a satisfactory method of examining magnetic distributions.

Chemical Society, March 19.—Dr. W. J. Russell, F.R.S., President, in the chair.—The following papers were read:—Molecular refraction and dispersion of various substances, by Dr. J. H. Gladstone, F.R.S. This paper contains a number of observations of refractive indices, with the optical constants calculated from them, and remarks on their bearing on chemical or physical theory. Observations on carbon bisulphide and benzene confirm the old conclusion that the specific refractive energy of a liquid is a constant not affected by temperature. Data relating to a number of carbon compounds are given; the molecular refraction and dispersion calculated from experiment are compared with those calculated from the values already assigned to the constituent elements. In most cases the experimental and theoretical numbers agree fairly well; in some cases, however, there is a discrepancy. This, of course, points to some difference in constitution. The molecular dispersion of amylene shows the increase for double-linked carbons characteristic of the allyl compounds previously examined, and the allyl and diallyl acetic acids. The xylenes differ considerably in their actual indices, but have almost identically the same molecular refraction and dispersion. The optical properties of safrol agree with the normal value calculated for four double-linked carbons; but anethol, cinnamene, and butenyl benzene, which have the same number of double linkings, give a refraction and especially a dispersion far above that required by theory, thus indicating the presence of carbon in a still more refractive and dispersive condition, to which the author drew attention in 1881. Some of the results afford fresh confirmation of the analogy between molecular refraction and dispersion and molecular magnetic rotation. The nitrogen compounds give results confirmatory of the two values previously assigned to that element in combination. Stannic ethide gives a refraction equivalent for tin 18·1; zincic ethide gives a value for zinc 15·9. The halogen compounds of silicon and titanium gave results confirmatory of the former refractive equivalents; the atomic dispersion of silicon came out about 0·32, and that of titanium about 8·7.—Contributions to our knowledge of the aconite alkaloids: on the crystalline alkaloid of *Aconitum napellus*, by W. R. Dunstan and W. H. Ince. The alkaloid was extracted from the root of *Aconitum napellus* by amyl alcohol. The yellowish crystals melted at 188°·4, and were found to be associated with a small quantity of a gummy amorphous base. They gave, on combustion, numbers agreeing fairly well with the formula $C_{33}H_{43}NO_{12}$, which is that proposed for aconitine by Wright and Luff. The alkaloid is purified by recrystallization from a mixture of alcohol and ether, or by conversion into its hydrobromide and regeneration of the alkaloid from the salt, or by regeneration from its crystalline aurochloride. It crystallizes in tabular prisms belonging to the rhombic system, is very slightly soluble in water and light petroleum, more soluble in ether and alcohol, most soluble in benzene and chloroform, and melts at 188°·5 (corr.). Previous observers state aconitine to be lævo-rotatory; the authors find an alcoholic solution to be dextro-rotatory $[\alpha]_D = + 10°·78$; the aqueous solution of the hydrobromide is, however, lævo-rotatory $[\alpha]_D = - 30°·47$. The pure alkaloid gave, on analysis, numbers corresponding to the formula $C_{33}H_{45}NO_{12}$. Two crystalline *aurochlorides* are obtained, $C_{33}H_{45}NO_{12}HAuCl_4$ (m.p. 135°·5), and $C_{33}H_{45}NO_{12}AuCl_3$ (m.p. 129°). *Dehydraconitine* or *apo-aconitine*, $C_{33}H_{43}NO_{11}$, is readily prepared by heating aconitine with saturated aqueous tartaric acid in closed tubes, melts at 186°·5, forms crystalline salts, and closely resembles the parent alkaloid. Three *aurochlorides* are obtained, $C_{33}H_{43}NO_{11}HAuCl_4$ (m.p. 141°). This salt on crystallization from aqueous alcohol forms a hydrate, $C_{33}A_{43}NO_{11}HAuCl_4H_2O$ (m.p. 129°), isomeric with aconitine aurochloride, into which it is easily converted. The third aurochloride, $C_{33}H_{43}NO_{11}AuCl_3$, melts at 147°·5. An *amorphous base* is obtained from aconitine, together with benzoic acid, by prolonged heating with water in a closed tube, and appears to be identical with the *aconine* of Wright and Luff. The amorphous base and its amorphous aurochloride gave, on analysis, numbers agreeing with the formulæ $C_{26}H_{41}NO_{11}$ and $C_{26}H_{41}NO_{11}HAuCl_4$.—The crystallographical characters of aconitine from *Aconitum napellus*, by A. E. Tutton. Aconitine crystallizes in the rhombic system. Habit prismatic; $a : b : c = 0·5456 : 1 : 0·3885$. It is a highly dispersive substance. The apparent acute angle of the optic axes in air 2E, for lithium light is 47° 0′, for sodium light 56° 10′, and for thallium light 65° 5′. Hence there is a dispersion of 18° 5′. The double refraction is positive.—The asymmetry of nitrogen in substituted ammonium compounds, by S. B. Schnyver. The primary object of the work was to produce stereo-isomers of pentavalent nitrogen compounds. The author has prepared quaternary ammonium compounds containing three different radicles: (1) by adding methyl iodide to diethylisoamylamine; (2) by adding isoamyl iodide to diethylmethylamine; (3) by adding ethyl iodide to ethylmethylisoamylamine. The platinochlorides of (1), (2), and (3) gave, on evaporation by heat, needle-shaped crystals belonging to the rhombic system. The platinochlorides of (1) and (2), on evaporation *in vacuo*, gave needle-shaped crystals belonging to the monoclinic system, which are easily converted into the rhombic variety; whilst (3), on evaporation *in vacuo*, gave needles which resembled those obtained on evaporation by heat. From these results the author concludes that this difference in crystalline form is due to the various arrangements of the radicles ethyl, methyl, isoamyl, and chlorine round the nitrogen atom, and therefore that the stereo-isomers are possibly capable of existence in the quaternary ammonium compounds.—Acetylcarbinol (acetol), $CH_3 . CO . CH_2OH$, by W. H. Perkin, Jun., F.R.S. Acetylcarbinol can be prepared in large quantities by adding freshly precipitated barium carbonate, in small quantities at a time, to a boiling aqueous solution of acetylcarbinyl acetate ($CH_3CO . CH_2 . OC_2H_3O$, prepared by digesting monochloracetone with potassium acetate in alcoholic solution). The product is purified by repeated fractional distillation under reduced pressure. Acetylcarbinol boils at 120°–122° (250 mm.), and at about 147° under ordinary pressures. When cooled in a mixture of ice and chlorhydric acid, it solidifies to a hard crystalline mass; its relative density at 15° = 1°·07915; magnetic rotation, 3·650. Sodium amalgam converts it quantitatively into methyl glycol.—The action of ethyl dichloracetate on the sodium derivative of ethyl malonate, by Dr. A. W. Bishop and W. H. Perkin, Jun., F.R.S. When a mixture of ethyl malonate (2 mols.), sodium ethylate (2 mols.), and ethyl dichloracetate (1 mol.) is digested in alcoholic solution in a reflux apparatus, and the product fractionally distilled, two new compounds are obtained: α-ethylic ethylenetricarboxylate $(CO_2Et)_2C : CH . CO_2Et$, and β-ethylic propanepentacarboxylate $(COOEt)_2 : CH . CH(COOEt) . CH(COOEt)_2$.—Benzoylacetic acid and some of its derivatives, Part 5, by W. H. Perkin, Jun., and J. Stenhouse. The preparation and properties of the following compounds are described in this paper:—Ethylic allylmethylbenzoylacetate, ethylic methyldibenzoylacetate, ethylic benzoylbenzoylacetate, benzylacetophenone, α-methyl-β-phenyllactic acid, α-ethyl-β-phenyllactic acid, and ethylic purpuralbenzoylacetate.—Syntheses with the aid of ethyl pentanetetracarboxylate, by W. H. Perkin, Jun., F.R.S., and B. Prentice. Ethylic pentanetetracarboxylate yields a disodium derivative, from which, by the action of alkyl iodides, higher homologues may be obtained, and these, on hydrolysis and subsequent splitting off of two molecules of carbon dioxide, yield higher homologues of pimelic acid,

$$\begin{aligned}(COOEt)_2 : CR . CH_2 . CH_2 . CH_2 . CR' : (COOEt)_2 + KOH \\ = (COOK)_2 : CR . CH_2 . CH_2 . CH_2 . CR'(COOK)_2 \\ + 4Et . OH,\end{aligned}$$

and

$$\begin{aligned}(COOH)_2 : CR . CH_2 . CH_2 . CH_2 . CR' : (COOH)_2 \\ = COOH . CHR . CH_2 . CH_2 . CH_2 . CHR' . COOH \\ + 2CO_2.\end{aligned}$$

The preparation and properties of ethyl dibenzylpentanetetracarboxylate, dibenzylpentanetetracarboxylic acid, and dibenzylpimelic acid are described.

Geological Society, March 25.—Dr. A. Geikie, F.R.S., President, in the chair.—The following communications were read:—Notes on Nautili and Ammonites, by S. S. Buckman.—On the drifts of Flamborough Head, by G. W. Lamplugh. The author describes in detail the characters and distribution of the glacial deposits on Flamborough Head, and classifies them as follows:—

Alluvial wash, fresh-water marls, &c. . . .	Recent.
Late glacial gravels	Glacial.
Upper boulder clay	
Intermediate series. Stratified beds, with bands of boulder clay	
Basement boulder clay	
Chalky rubble	
"Infra-glacial" beds of Sewerby and Speeton.	

He discusses their relationship with other drifts, and arrives at the following conclusions:—(1) The glacial deposits are divisible into upper and lower boulder clay, with an intermediate series. (2) The lower clay is a continuation of the basement clay of Holderness, and is the product of the first general glaciation of the area. The intermediate series passes laterally into the purple clays of Holderness, and has been deposited at the edge of the ice-sheet. The upper clay includes the Hessle clay of Holderness, and marks the latest glaciation of this region. (3) The fossiliferous beds of Sewerby ("buried cliff beds") and Speeton ("estuarine shell bed") are older than the basement clay, and therefore than the earliest glaciation. (4) The glaciation was effected by land-ice of extraneous origin, which moved coastwise down the North Sea, and did not overflow the greater part of the Yorkshire Wolds. (5) Neither the boulder clays nor the intermediate gravels are of marine origin, the shells which occur in them being derivative. (6) The ice-sheet seems to have filled the North Sea basin in this latitude from the commencement of the glaciation until its close. There is no clear evidence here for a mild interglacial period, but only for extensive fluctuations of the margin of the ice. After the reading of this paper there was a discussion, in which Mr. Clement Reid, Mr. Whitaker, Mr. E. T. Newton, Prof. Hughes, the President, and the author took part.—On a phosphatic chalk with *Belemnitella quadrata* at Taplow, by A. Strahan. (Communicated by permission of the Director-General of the Geological Survey.) Two beds of brown chalk in an old pit near Taplow Court owe their colour to a multitude of brown grains. These grains are almost entirely of organic origin, foraminifera and shell prisms forming the bulk of them. Mr. Player has analyzed specimens of the brown chalk, and finds that it contains from 16 to 35 per cent. of phosphate of lime. The tests as well as the contents of the foraminifera seem to have been phosphatized, the phosphate appearing as a translucent film in the former case, and as an opaque mass in the latter. In the case of the prisms of molluscan shells, the whole of the phosphate appears to be in the opaque form. Minute coprolites also occur, together with many small chips of fish-bone, in which Dr. Hinde has recognized lacunæ, while some have been identified by Mr. E. T. Newton as portions of fish teeth. Mr. Player observes that the phosphate occurs in such a condition that it would not improbably serve as a valuable fertilizer, without conversion into superphosphate. This condition is probably due to the partial replacement of carbonate of lime by phosphate in the organisms. The removal of the remaining carbonate leaves the phosphate in a honeycombed state, peculiarly favourable for attack by the acids in the soil. The author comments upon the resemblance of the deposit to the phosphatic chalk with *Belemnitella quadrata* which is largely worked in Northern France, and upon a less striking resemblance with that of Ciply, which is at a higher horizon. Some remarks on this paper having been made by Dr. G. J. Hinde, Mr. Whitaker, and Prof. Judd, the President, alluding to the geological and economic interest of the discovery described in the paper, said that, though the area occupied by the phosphatic layers seemed to be small, there was good reason to hope that somewhere else in the upper chalk districts the same or similar bands might yet be found. The search for such deposits would now be stimulated by the information so fully supplied by the author, who himself would no doubt follow up his observations at Taplow by a thorough examination of the higher members of the chalk in the east of England.

Entomological Society, April 1.—Prof. R. Meldola, F.R.S., Vice-President, in the chair.—Captain H. J. Elwes showed a small but very interesting collection of butterflies from Laggan Alberta, North-West Territory of Canada, taken by Mr. Bean at high elevations in the Rocky Mountains. Amongst them were *Colias elis*, Streck., which seemed to be very close to, if not identical with, *C. hecla* of Europe, *Argynnis alberta*, W. H. Edw., and *Chionobas subhyalina*, W. H. Edw. The resemblance between the butterflies of this locality and those found on the Fells of Lapland was very striking, some of the species being identical, and others very closely allied. Captain Elwes said that it was another proof, if one were wanted, of the uniformity of the butterflies found throughout the boreal region in the Old and New Worlds.—Mr. G. C. Champion exhibited several insects recently received from Mr. J. J. Walker, from Hobart, Tasmania. The collection included a curious species of *Forficulidæ*, from the summit of Mount Wellington; two mimetic species of *Œdemeridæ* belonging to the genus *Pseudolycus*, Guér., and the corresponding *Lycidæ*, which were found with them; also specimens of both sexes of *Lamprima rutilans*, Er.—Mr. N. M. Richardson exhibited a specimen of *Zygæna filipendulæ* with five wings; four specimens of *Gelechia ocellatella*, including a pink variety, bred from *Beta maritima;* four specimens of *Tinea subtilella*, a species new to Britain, taken last August in the Isle of Portland; also specimens of *Nepticula auromarginella*, a species new to Britain, bred from larvæ taken near Weymouth on bramble.—Mr. C. Fenn exhibited a series of *Tæniocampa instabilis*, which had been bred out of doors during the recent severe weather. They were all bred from ova laid by the same female, and many of them were of an abnormally pale colour. Mr. Fenn said that, according to Mr. Merrifield's theory, these pale specimens, in consequence of the temperature to which they had been subjected in the pupal state, ought to have been very dark. Mr. Jenner Weir said he had never before seen any specimens of so light a colour.—Mr. W. Dannatt exhibited a butterfly belonging to the genus *Crenis*, recently received from the Lower Congo. He said he believed the species was undescribed.—Mr. G. A. J. Rothney sent for exhibition several specimens of an ant (*Sima rufo-nigra*), from Bengal, together with specimens of a small sand wasp (*Rhinopsis ruficornis*) and a spider (*Salticus*), both of which closely mimicked the ant. It was stated that all the specimens exhibited had lately been received from Mr. R. C. Wroughton, of Poona. Mr. Rothney also communicated a short paper on the subject of these ants, and the mimicking sand wasps and spiders, entitled "Further Notes on Indian Ants."—Mr. G. C. Champion read a paper entitled "On the Coleoptera collected by Mr. J. J. Walker, R.N., in the neighbourhood of Gibraltar, with descriptions of new species." At the conclusion a discussion ensued, in which Mr. Kirby, Captain Elwes, Mr. McLachlan, Mr. Jenner Weir, Dr. Sharp, and Mr. Crowley took part.

DUBLIN.

Royal Society, March 18.—On the cause of double lines in the spectra of gases, by Dr. G. Johnstone Stoney, F.R.S. The alternations of electro-magnetic stress in the ether which constitute light form an undulation which is propagated through the ether under the same laws as the transverse vibrations of an incompressible elastic solid (see McCullagh's papers, *passim*). It is convenient first to regard certain points in the molecules of the gas as acting dynamically on such a medium, to inquire what oscillations within the molecules would impart to the medium the vibrations which correspond to the observed lines in the spectrum, and afterwards to correct the investigation so as to transfer it from the dynamical hypothesis of light to the electro-magnetic theory. Let us then suppose that a point P in the molecule acts on the ether, and is set oscillating within the molecule by the inter-molecular encounters. Its undisturbed path will be represented by the simple elliptic motion

$$\left.\begin{aligned} x &= a \,.\, \cos\theta \\ y &= b \,.\, \sin\theta \end{aligned}\right\} \quad . \; . \; . \; . \; . \; . \; . \; . \; . \qquad (1)$$

θ being written for $2\pi mt/\tau$, in which m is the oscillation-frequency in the time τ. Perturbating forces operating within the molecule would cause an apsidal motion of the ellipse in its own plane, and perhaps a motion of the nodes of this plane upon the invariable plane. The apsidal motion is represented by

$$\left.\begin{aligned} \mathrm{X} &= a \,.\, \cos\theta\cos\omega - b \,.\, \sin\theta\sin\omega \\ \mathrm{Y} &= a \,.\, \cos\theta\sin\omega + b \,.\, \sin\theta\cos\omega \end{aligned}\right\} \quad . \; . \qquad (2)$$

where $\omega = 2\pi nt/\tau$, n being the oscillation-frequency of the apsidal revolutions. Equations (2) are equivalent to

$$\left.\begin{aligned} \mathrm{X} &= \frac{a+b}{2} \,.\, \cos\,(\theta+\omega) + \frac{a-b}{2} \,.\, \cos\,(\theta-\omega) \\ \mathrm{Y} &= \frac{a+b}{2} \,.\, \sin\,(\theta+\omega) - \frac{a-b}{2} \,.\, \sin\,(\theta-\omega) \end{aligned}\right\} \; . \quad (3)$$

a motion which, when imparted to the surrounding medium, represents a pair of lines in the spectrum with oscillation-frequencies $(m + n)$, and $(m - n)$, and intensities which are to one another in the ratio of $(a + b)^2$ to $(a - b)^2$. These quantities are not altered when the various positions in which the molecules chance to be at any one instant are taken into account. Equations (2) and (3) represent an apsidal motion in the same direction as the primary elliptic motion, and in this case the more refrangible line is the brighter. If the apsidal motion is in the opposite direction, we shall have to change the sign of ω in equations (2) and (3). This does not alter the positions, but it is now the less refrangible line which is the brighter. A third case occurs when the primary motion is an oscillation in a straight line instead of in an ellipse: here $b = 0$, and the intensities of the two lines become equal. All three cases occur in the observed spectra of gases. A motion of the nodes on the invariable plane will give rise to additional pairs of lines, and if the inclination of the two planes is small, one of the pairs only is conspicuous. Such a motion may be what occasions the faint lines that have sometimes been called satellites. It would at the same time cause a shifting of the position of the bright lines—a matter of importance in grouping the lines of a spectrum into series. To pass from the dynamical investigation to the electro-magnetic, attention must be given to Faraday's law of electrolysis, which is equivalent to the statement that in electrolysis a definite quantity of electricity, the same in all cases, passes for each chemical bond that is ruptured. The author called attention to this form of the law in a communication made to the British Association in 1874 (see Scientific Proceedings of the Royal Dublin Society of February 1881, and *Philosophical Magazine* for May 1881, p. 385); and showed that the amount of this quantity of electricity is about the twentiethet (that is, $1/10^{20}$, or a unit in the twentieth place of decimals) of the usual electro-magnetic unit of electricity, *i.e.* the unit of the ohm series. This is the same as three eleventhets (or $3/10^{11}$) of the much smaller C.G.S. electrostatic unit of quantity. A charge of this amount is associated in the chemical atom with each bond. It appears to be irremovable from the atom, but becomes for the most part disguised when atoms chemically unite. If this charge be lodged at the point P of the molecule which undergoes the motion described above, the oscillation of the charge will cause an electro-magnetic undulation in the surrounding ether. The only change that has to be made in our investigation to adapt it to this state of things is to change θ into $\frac{\pi}{2} + \theta$, *i.e.* a mere change of phase. We in this way represent the fact that it is the direction and velocity of the motion of P, not the direction and length of its radius vector, which determine the direction and intensity of the electro-magnetic stresses in the surrounding ether. We have further to correct for the change of phase, about one-fourth of a vibration-period, consequent upon what takes place in the immediate vicinity of the moving charge. Within the molecule itself, the oscillation of the permanent charge probably causes electric displacements in other parts of the molecule, and to the reaction of these upon the oscillating charge we may perhaps attribute those perturbations of which the double lines in the spectrum give evidence. The periodic times of all the molecular motions dealt with in this paper, of the primary and apsidal motions, of the motion of the nodes, of change of ellipticity, &c., and also the form of the ellipse, can be deduced from what may be observed in the spectrum.

PARIS.

Academy of Sciences, March 31.—M. Duchartre in the chair.—On the third meeting of the Permanent International Committee for the execution of the photographic map of the heavens, by Admiral Mouchez (see NATURE, April 2, p. 516).—A new gyroscopic apparatus, by M. G. Sire.—New observations on the Marseilles sardine, by M. A. F. Marion.—The earthquakes at Algiers on January 15 and 16, by M. A. Pomel. It is remarked that no apparent relation appears to exist between the seismic movement and the geological structure of the region affected.—New nebulæ discovered at Paris Observatory, by M. G. Bigourdan. A list is given of new and interesting nebulæ discovered by M. Bigourdan between 0 hours and 9 hours of right ascension in the years 1887-90.—On the variations observed in the latitude of a single place, by M. A. Gaillot. Diurnal variations in latitude have been found from a discussion of meridian observations made at Paris during the years 1854-57. An annual variation does not appear very definitely marked. The results indicate that all hypotheses relative to the cause of the phenomenon are premature, for in all probability there is no real variability in the direction of the earth's axis, the question being merely one of temperature and refraction.—On the theory of conformable representations, by M. Paul Painlevé.—On the pressure in the interior of magnetic or dielectric media, by M. P. Duhem.—Propagation of Hertz's electrical undulation in air, by MM. Édouard Sarasin and Lucien de la Rive. The most important result obtained is, that the velocity of propagation of Hertz's electrical undulations across air is very sensibly the same as that with which they are transmitted along a wire conductor.—New method for the investigation of feeble bands in banded spectra; application to hydrocarbon spectra, by M. H. Deslandres. It is shown that the bands or flutings characteristic of hydrocarbon spectra occur periodically. M. Deslandres has discovered three new bands at λ 438·19, λ 437·13, and λ 436·5. These bands are not given by the combustion of hydrocarbons, but they may be seen with the ordinary bands of hydrocarbon and cyanogen in the electric arc and in the cyanogen flame. By the application of the above law, M. Deslandres has been able to determine that these bands really belong to hydrocarbon.—On the origin of the higher alcohols contained in industrial ferments, by M. L. Lindet.—On vegetable hæmatine, by M. T. L. Phipson.—On the employment of liquefied carbonic acid for the rapid filtration and sterilization of organic liquids, by M. A. d'Arsonval.—The males of the Ostracoda of sweet water, by M. R. Moniez.—On the influence of salinity in the formation of starch in chlorophyllian vegetable organs, by M. Pierre Lesage. According to the author, the presence of salt in waters is an obstacle to the production of starch in vegetable tissue.—Note on the simultaneous disengagement of oxygen and carbon dioxide in Cacti, by M. E. Aubert. Some observations show that Cacti, when submitted to a temperature of about 35°, and a light of moderate intensity, simultaneously emit oxygen and carbon dioxide.—The artificial reproduction of amphibole, by M. K. de Kroustchoff. The author has been able to produce crystals of this rock by synthesis.—Some magnetic anomalies observed in the centre of Russia in Europe, by General Alexis de Tillo. Anomalous magnetic disturbances are described, similar to those found by Profs. Thorpe and Rücker in England.—A definite depression in the centre of the Asiatic continent, by the same author. Some barometric readings indicate that a little south of the town of Tourfan, in the centre of the Asiatic continent, there exists a depression 50 metres below the level of the ocean.

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